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reproductive structures, because vegetative structures can be presented without all sorts of details, and because reproductive structures lead so easily to general questions and plant systems. GOETH's theory of metamorphosis is presented and a modified view of this theory seems to dominate the discussion. This general part occupies only 31 pages.

The second, or special part, presents the various groups from the algae up to the flowering plants, and occupies 120 pages. The reading should not be very difficult for an educated man, interested in botany, but not a professional botanist. The technical terms, especially those used in describing flowering plants, are rather numerous.—CHARLES J. CHAMBERLAIN.

NOTES FOR STUDENTS

Recent work on tropisms.—For orthotropic organs FITTING and others have proved that geo-excitation increases with the sine of the angle of displacement from the normal or labile rest position. Therefore, the horizontal position gives maximum stimulation, and all equal displacements below and above it equal stimulation. NOACK asserts that this physiological response does not parallel any known change in the energy of gravity itself with variation of the angle, and is not capable of direct physical explanation.

NOACK[2] inquires whether photo-excitation of orthotropic organs obeys the sine of angle law. Assuming constant source of unilateral light, the intensity falling on a given surface of the plant organ varies as the cosine of the angle of deviation from the perpendicular, or as the sine of the angle of deviation from the rest positions. On the basis of light intensity, therefore, one might expect the sine law to hold. NOACK finds, however, that intensity of the illumination of the flank of the organ is not the sole factor, but the direction of the striking rays is important, hence the sine law does not apply. He studied chiefly the coleoptile of *Avena*. The following table shows the "Schwelle" (product of light intensity in candle-power actually falling on the illuminated surface of the organ by least time in seconds necessary to give a final response in 50 per cent of the organs) and presentation time under constant light source for the various angles of deviation from the normal rest position.

Angle	15°	30°	45°	65°	90°	105°	120°	135°	150°
Schwelle	7.3	9.5	11.9	11.18	12.2	15.8	20.3	23.7	32.4 (C.M.S.)
Presentation time	28.2	19.0	16.8	12.9	12.2	16.4	23.6	33.5	64.8

The "Schwelle" for the different angles shows the organ is more sensitive to impinging light from above than from below the horizontal, and that this sensitiveness increases continuously from the inverse to the normal rest position. This increase follows a regular law, as is shown by the fact that the product of the supplement of the angle of deviation from the normal rest position by the "Schwelle" is a constant. These facts indicate that the organ is most excited by light striking it from directly above, though of course this produces no response. The "Schwelle" for this position is calculated at 6.7 C.M.S. Some measurements were made also on the sporangiophore of *Phycomyces* and on the mustard seedling. In the latter, as in *Avena*, the "Schwelle" decreases as the angle of impinging rays passes from the inverse to the normal rest position, while in *Phycomyces* just the reverse behavior appears. With light striking the organs at right angles, mustard has a "Schwelle" of 240 and *Phycomyces* 60, against 12 C.M.S. for oats. NOACK believes he has settled a long-contested point by establishing that the direction of the impinging ray and not the difference in light intensity on two flanks is the determining factor in phototropism. He also takes his results as evidence for the polarization conception of FITTING in conduction of the phototropic stimulus. He believes photoperception and presention are too complex to be explained as simple photochemical reactions, as some have attempted to do.

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[2] NOACK, KONRAD, Die Bedeutung der schiefen Lichtrichtung für die Helioperzeption parallelotroper Organe. Zeitschr. Bot. **6**:1–79. 1914.

BOYSEN-JENSEN[3] repeats and confirms his earlier experiments which showed that the conduction of the phototropic stimulus in the coleoptile of *Avena* is localized in the half of the seedling not illuminated. He reasserts that FITTING'S conception of the polarization in all cells of the organ determined by the direction of the impinging rays is untenable, and finds no evidence for VAN DER WOLK'S claim of wound effects compensating for phototropism.

RISS,[4] working in JOST'S laboratory has devised a special sort of centrifuge for the purpose of studying the effect on orthotropic stems and roots of applying centrifugal force equilaterally at right angles to the longitudinal axis of these organs. Such application of centrifugal force, unlike unilaterally applied light, has no tonic effect on the plant organ. This finding is contrary to the assumption of BACH. Such equilaterally applied centrifugal force also causes no modification in the geotropic effect of unilaterally applied gravity, whether the former be applied before, during, or after the latter. In some cases the equilateral force was 20 times the unilateral. This leads to the important conclusion that WEBER'S law does not apply to geotropic discriminative sensibility. Centrifugal force acting in the longitudinal direction inhibits the geotropic effect of a right angle stimulus. The action of gravity at an oblique angle on the orthotropic organ is not a result of the right angle components alone, but the effect of the latter is inhibited by the longitudinal components. For this reason, the author concludes that the sine of angle law of FITTING and BACH does not strictly apply even between 45° and 90°, although the deviation here is slight. The horizontal position of the organ is the position of maximum geo-stimulation both because gravity acts at right angles to the organ and because no longitudinal components are present.

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[3] BOYSEN-JENSEN, P., Über die Leitung des phototropischen Reizes in der Avenakoleoptile. Ber. Deutsch. Bot. Gesells. **31**:559–566. 1914.

[4] RISS, MARIE-MARTHE, Über den Einfluss allseitig und in der Langsrichtung wirkender Schwerkraft auf Wurzeln. Jahrb. Wiss. Bot. **53**:157–209. 1913.

DEWERS[5] has applied the PICCARD rotation method to determining the distribution of geo-sensitiveness in various plant organs.[6] In the root of *Lupinus albus* the greater sensitiveness lies in the terminal 2.5 mm. The hypocotyl of *Helianthus* always gives a permanent *S* response due to low irritability and slow conduction of the stimuli. The method does not determine the distribution of geo-sensitiveness in this organ. In *Hordeum vulgare*, *Panicum miliaceum*, and *Setaria italica*, the coleoptile is much more sensitive than the internode, although the internode is slightly sensitive in all these, most so in *Panicum*. The sensitiveness in the coleoptile of *Hordeum* is about equally distributed, so that when about half of the organ projects across the axis of the centrifuge an *S* response occurs which later entirely straightens out. Apparently there is about equal acropetal and basipetal conduction of the stimulus in the two directions. Whether this occurs by separate paths in the two directions is not known. The geo-irritability of the internode of *Panicum* is higher than that of *Sorghum*, while the reverse is true of photosensitiveness. In general, however, DEWERS finds that geo-conduction and photoconduction and reaction run parallel in these organs. In general, those organs that show quick perceiving power show rapid conduction, and those showing slow perceiving power show slow conduction. The coleoptile of *Hordeum* belongs to the first class, and the hypocotyl of *Helianthus* to the second. In an "Anhang" the author reports that he was unable to find a destarching agent, for the purpose of throwing some light on the statolith theory, the application of which did not greatly injure the root. He tried Al_2Cl_6 and $Al_2(SO_4)_3$ alone and in combination with Knop's solution and KH_2PO_4.

PORODKO[7] has studied chemotropic response of roots to various alkalies and alkali earth salts. The experiments consisted of a square millimeter of filter paper saturated in the salt solution applied to the side of the roots in darkened moist chambers. In lower concentrations positive chemotropic responses occurred; in higher, negative chemotropic responses; and in still higher positive, chemo-traumatic responses. PORODKO asserts that the first response is a true tropic response, for perception is localized in the tip, bending is due to growth, and the concentration producing the response is comparatively low. It is also not osmotropic, for the concentrations producing it in the various salts show great variation. The positive and probably the negative response is due to the action of ions. The effect of the ions beginning with those most effective is (1) for positive response, tartrate>citr.>SO_4>acet.>ClO_3>Cl>NO_3>J >CNS; Rb>Cs>K>Li>Na; (2) for negative response, (*a*) for alkali salts, acet.>tartr.>J>Cl>Citr.>ClO_3>CNS>SO_4>NO_3; Na>Li>K>Cs>Rb; (*b*) for salts of alkali earths, J>Br>acet.>Cl.; Mg>Ca, Ba, Sr.

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[5] DEWERS, F., Untersuchungen über die Verteilung der geotropischen Sensibilität an Wurzeln und Keimsprossen. Beih. Bot. Centralbl. **31**^{1}:309–357. 1914.

[6] For methods see BOT. GAZ. **47**:482, 483. 1909; and PFEFFER'S Plant physiol. Eng. ed. **3**:419.

[7] PORODKO, TH. M., Vergleichende Untersuchungen über die Tropismen. Ber. Deutsch. Bot. Gesells. **32**:25–35. 1914.

The bromide and perhaps the iodide of alkali earths do not produce the positive response. For negative chemotropism, salts of alkali earths are about 10 times as effective as those of the alkalies. PORODKO believes from the relative effectiveness of ions that the negative excitation involves coagulation of cell lipoids as well as proteins, and that both the positive and negative irritability are lined up with change of condition of cell colloids. Our knowledge in this field is too limited, however, to follow the parallel in any detail.—WILLIAM CROCKER.

A theory of evolution.—Lest we forget that the method of evolution remains undemonstrated, that evolution itself is somewhat of a scientific dogma, it is desirable occasionally to have our attention called to the fact that scarcely two even of the clearest-headed of our contemporary thinkers hold the same views regarding it. Read BERGSON, BUTLER, DEVRIES, SEMON, WEISMANN. Their works are lawyers' briefs, written to uphold the importance of a single possible evolutionary cause to the greater or less neglect of all others; but they are remarkable briefs for all that. Evolution is due entirely to a directive force within the organism; evolution is due wholly to imperfections in the machinery of heredity and has no directive aim whatever; evolution is due solely to external causes; it is gradual, it is discontinuous; it is continual, it is periodic. One is often led to believe that no middle ground, no combination of methods is possible; moreover, it is often the individuals that strum continually on a few notes, who force recognition of tunes labeled conspicuously with their own personalities, by loud and persistent reiteration.

The latest writer to be enrolled as an exponent of a unique cause of evolution is LOTSY.[8] The unique cause is hybridization and the author's brief has been extraordinarily well done. As the paper is introduced by the following statement, the words "unique cause" do not exaggerate the position taken:

> Toutes les théories de l'évolution, y compris celle de Lamarck, Darwin et DeVries, s'appuient sur l'hypothèse, ou sur la prétendue preuve, qu'il existe d'une façon ou d'une autre une variabilité héréditaire. Le présent travail a pour but de prouver que cette hypothèse se base sur une erreur; qu'il n'y a pas de variabilité héréditaire, sous aucune forme, mais que les expèces sont constantes.

LOTSY does not believe that Linnean species are constant, but that forms truly homozygous are constant. His outline of the growth of evolutionary belief shows this.

A. The period when it was believed that the characters of an individual were transmitted as a whole.

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[8] LOTSY, J. P., La théorie du croisement. Arch. Néerland. Sci. Exact. et Nat. III B **2**:1–61. 1914.